



## Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact [support@jstor.org](mailto:support@jstor.org).

# SCIENCE

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING, Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; JOSEPH Le CONTE, Geology; W. M. DAVIS, Physiography; HENRY F. OSBORN, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; WILLIAM H. WELCH, Pathology; J. McKEEN CATTELL, Psychology; J. W. POWELL, Anthropology.

FRIDAY, MAY 4, 1900.

## CONTENTS:

<i>The Medical School of the Future:</i> PROFESSOR HENRY P. BOWDITCH.....	681
<i>National Standardizing Bureau</i> .....	696
<i>A New Enzyme of General Occurrence in Organisms:</i> DR. OSCAR LOEW.....	701
<i>The Recent Annual Reception and Exhibition of the New York Academy of Sciences:</i> PROFESSOR J. F. KEMP.....	702
<i>Scientific Books:—</i>	
<i>The International Geography:</i> PROFESSOR RICHARD E. DODGE. <i>Stout's Manual of Psychology:</i> DR. I. MADISON BENTLEY. <i>Jaubert's matières odorantes artificielles:</i> DR. MARSTON TAYLOR BOGERT. <i>Books Received</i> .....	704
<i>Societies and Academies:—</i>	
<i>The Academy of Science of St. Louis:</i> PROFESSOR WILLIAM TRELEASE. <i>The Torrey Botanical Club:</i> PROFESSOR EDWARD S. BURGESS. <i>Biological Society of Washington:</i> F. A. LUCAS.	711
<i>Discussion and Correspondence:—</i>	
<i>The Official Spelling of Porto Rico:</i> DR. ROBERT T. HILL. <i>Linguistic Families in Mexico:</i> PROFESSOR O. T. MASON. <i>Hemianopsia in Migrate.</i> PROFESSOR J. MARK BALDWIN. <i>The Development of Photographic Plates in the Light:</i> PROFESSOR FRANCIS E. NIPHER.....	712
<i>The Topographic Survey of Ohio:</i> PROFESSOR ALBERT A. WRIGHT.....	714
<i>The Archæological Report of Ontario:</i> HARLAN I. SMITH.....	715
<i>Experiment Station Exhibit at the Paris Exposition.</i>	715
<i>Scientific Notes and News</i> .....	716
<i>University and Educational News</i> .....	719

## THE MEDICAL SCHOOL OF THE FUTURE.\*

AMONG the intellectual movements that have characterized the century now drawing to a close there is perhaps no one more deserving of careful study than that which is concerned with providing education for people in the school, the academy and the university. The importance of popular education became apparent in proportion as political freedom was secured for the people. Thus Viscount Sherbrooke, better known as the Hon. Robert Lowe, in the reform debates of 1866 and 1867, after the passage of a bill for the extension of the suffrage, uttered the well known words: "We must now at least educate our masters." The same sentiment has also more recently been embodied in the inscription on the Boston Public Library. "The Commonwealth requires the education of the people as the safeguard of order and liberty," and in the presidential address of Dr. J. M. Bodine,† at the meeting of the Association of American Colleges in 1897 we find the same idea thus expressed, "In America the citizen is king. The king must be educated to wield aright his ballot-sceptre."

For many years educators looked upon their work with no little complacency. The educational systems of the various civilized

\* Address by the president before the Fifth Triennial Congress of American Physicians and Surgeons given at Washington on May 2nd.

† *American Practitioner and News*, June 26, 1897.

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor, J. McKeen Cattell, Garrison-on-Hudson, N. Y.

countries were supposed to be well adapted to the ends in view, and educational exhibits have been generally regarded as important features of international expositions. But within the memory of most of those now before me signs of serious discontent have not been wanting. Education has not always been found to furnish the required safeguards for order and liberty. Highly educated men have often been found singularly lacking in mental balance. Schools for the inculcation of 'common sense' have never yet been established. Even the great development of psychology as an experimental science, which has occurred chiefly within the last twenty-five years, though it has served to establish many laws of mental action, has thus far failed to justify the hope that pedagogy may find in psychology a foundation for the erection of rational systems of education. Indeed we have recently been told by one of the ablest exponents of this science that it is a great mistake for teachers to "think that psychology, being the science of the mind's laws, is something from which they can deduce definite programs and schemes and methods for immediate schoolroom use. Psychology is a science and teaching is an art. A science only lays down lines within which the rules of the art must fall, laws which the follower of the art must not transgress: but what particular thing he shall positively do within those lines is left exclusively to his own genius."\*

Even this general guidance has been very imperfectly afforded, for the limits set by the science of psychology to the art of teaching have never been precisely defined. In fact the most fundamental question of all, viz, the relation of mental to physical development has not yet been settled, though much material for its study has been collected. It is not therefore surprising that in many countries teachers have made too

great demands upon the time and strength of growing children.

This has been clearly the case in some parts of Germany where schoolboys from eight to fifteen years of age have found their vital energy so far exhausted by the school work required of them that they have lost all inclination for vigorous athletic amusements so naturally indulged in by Anglo-Saxon boys. The deterioration of the race as a result of too close application to intellectual pursuits, to the neglect of the physique, has been fortunately obviated, in the case of Germany, by the army system which takes entire possession of the youth before it is too late and, by requiring him to devote three years to the education of his body, turns him out, at the end of that period, a young man with mind and body, trained to a high degree of efficiency, well fitted for civil as well as military pursuits and comparing favorably in all respects with men of his age in other nations. Looked at from this point of view the German army must be regarded as an important part of the educational system of the country though as a piece of educational machinery its workings cannot be considered economical. In fact the absurdity of depending upon the army to remedy the defects of the school system has long since been forced upon the attention of German educators and the difficulties above alluded to are now in a fair way to be removed.

In our own country difficulties of quite a different kind have been met with. Here the great danger which threatens our system of popular education arises from its close association with party politics. The office of a school committee man in one of our large cities has been well described as "the smallest coin in which politicians pay their debts," and as long as the education of our children continues to be entrusted largely to men who consider their position on a school board as the lowest step of the political

\* W. James, 'Talks to Teachers,' p. 7.

ladder, there is small hope of the adoption of rational methods of education. Moreover this intimate alliance between education and politics greatly aids the efforts of persons more zealous than discreet to direct the instruction of children in accordance with their own special views. Thus nearly all the states of the union have upon their statute books laws requiring the physiological action of alcohol to be taught to children in all grades of the public schools. These laws violate the first principles of pedagogy inasmuch as the physiological action of a drug cannot possibly be understood without a familiarity with anatomy, physiology and chemistry which school children cannot be supposed to possess. They have been passed at the bidding of total abstinence associations, sometimes in opposition to the earnest protests of the teachers entrusted with their execution. How these excrescences upon our educational system may be best removed and the work of instruction placed under the control of those best qualified to direct it are questions demanding serious consideration.

I have mentioned these instances in which great educational systems have been found wanting merely for the sake of pointing out that the critics of our methods of medical education, who, as Professor Exner\* has shown, are now raising their voices in every land, do but give a special expression to a wide spread feeling that our educational systems are not accomplishing all the objects for which they have been devised, and that the discontent which they imply is but a healthy dissatisfaction with the results thus far accomplished. May the time be far distant when those in charge of our educational interests shall rest content with what they have achieved, for this will indicate that a state of stagnation has been reached similar to that which characterizes the institutions of the Celestial Empire, and that no further

attempt is to be made to adapt our methods of instruction to the constantly widening domain of human knowledge and experience.

It may, perhaps, be well for me at this point to offer a few words in explanation of the selection of such a well-worn theme as medical education as the subject of my remarks this evening. It is true that in recent years the subject has been a favorite one with those who have been called upon to address medical associations or classes of graduating students, and if, in spite of this fact, I venture to add another address to the fast growing literature of the subject, my justification may be found in the following reasons: In the first place it must be borne in mind that such addresses are very quickly forgotten "Were it not so," as Dr. Billings has remarked, "it would be a hard world for address-givers." In the second place, the progress of medicine at the present time is so rapid that new points of view are constantly being secured, and it is, therefore, not at all impossible that, even at comparatively short intervals, new and valuable suggestions may be made both with regard to subjects to be taught and to methods to be employed in giving the instruction.

Lastly, it so happens that during the academic year, now nearly completed, the faculty of the Harvard Medical School has inaugurated an entirely new plan of instruction in the sciences of anatomy, physiology and pathology. This scheme, though still in the experimental stage, embodies ideas of such fundamental importance in medical education that its presentation to a representative body of the medical profession seems to me to be peculiarly appropriate.

I shall, therefore, ask you to consider with me this evening what lessons the faculty of a modern medical school may draw from recent advances in medical science and recent experience in medical education or, in other words, on what lines the in-

\* *Wiener Klinische Wochenschrift*, 1900, No. 3.

struction of a medical school of the first rank is likely, in the immediate future, to be organized. I say in the *immediate* future for what changes are in store for us in the course of the next few decades it is equally impossible to foresee and useless to speculate.

#### RELATION OF MEDICAL SCHOOLS TO UNIVERSITIES.

One of the most hopeful signs of the times in the field of medical education is the growing tendency of the better schools to ally themselves to universities and of universities to establish medical departments. Of the great advantages to medical education which may be expected from this union it is unnecessary for me to speak, for they formed the subject of a thoughtful discourse delivered by the last president of this congress at Yale University in 1888.\* The twelve years that have elapsed since he spoke have brought accumulating evidence of the soundness of his views. In fact, it is difficult to see how a private medical school of the joint stock company type can ever, in the future, rise to the first rank, for such a school is not much more likely to attract endowments than a cotton mill, and without endowments the enormous expenses of a modern first-class medical school cannot possibly be met.

Great as are the benefits to a medical school of thus forming a department of a great university, the advantages of the union are not wholly on one side. Besides the increase of prestige secured to the University by the broadening of its functions, the establishment of a medical school as part of the university organization greatly facilitates the instruction of those students who, without any intention of becoming physicians, seek in the study of the medical sciences a means of general culture and mental discipline.

\* *New Englander and Yale Review*, Sept., 1888.

The relations between the governing body of a university and its medical faculty in matters of administration are often defined by custom and tradition rather than by statutory provisions, and vary considerably in different institutions. In general, two methods of government may be distinguished. Either the initiative is left with the teaching faculty, the governing body exercising simply a veto power, or the governing body acts directly without necessarily asking advice from the faculty or its members. The former method of government is most likely to be found in those cases in which a well-established medical school has allied itself to a university for the sake of the mutual benefits that may ensue from the union, and the latter method in those cases in which a university has completed its organization by the creation of a medical department. Both methods have certain advantages and neither is without its drawbacks. In all cases men are more important than methods. On the one hand, the collective judgment of a teaching faculty on matters relating to medical education, is likely to be of more value than that of a governing body which may not, and generally does not, include physicians among its members. On the other hand, personal and selfish considerations are perhaps more apt to sway the judgment of a faculty than that of a body of trustees, especially when the question is that of the appointment of teachers. That this is not a serious danger, however, the experience of Germany seems clearly to show, for in that country, as Dr. Farlow has recently pointed out, the faculty 'has more power in regard to appointments and the general policy of the university' \* than with us, and yet we find there the custom of calling professors from one university to another, fully established; a custom which

\* Presidential address. *Am. Soc. of Naturalists*, Dec., 1899. *SCIENCE*, Jan. 5, 1900.

must be regarded as one of the strongest influences in maintaining a high standard of educational efficiency. On the whole, therefore, even with this possibility of error, the judgment of a faculty would seem to be the safer guide, and there are probably few boards of trustees who would feel themselves justified in disregarding it altogether.

The above-mentioned advantages of a union between a medical school and a university will naturally become more obvious as the problems of medical education become more complex, and the methods of instruction more costly. Hence we may expect in the near future to find all of the better class of medical schools under the ægis of a university, and we may reasonably hope that this change will be associated with a diminution of the total number of medical schools now so greatly in excess of the needs of the country.

The union of a medical school with a university at once compels the consideration of the proper relation between the academic department and the professional school. To say that the former should be the feeder of the latter and that the holding of an A.B. degree should be the condition of admission to professional studies, is to adopt the position taken by two of our leading medical schools. The A.B. degree, however, since the introduction of the elective system, no longer stands for a definite amount and kind of training. Hence the Johns Hopkins Medical School demands not only the diploma, but also evidence of ability to read French and German and of laboratory training, in physics, chemistry and biology. The Harvard Medical School is content to accept the A.B. diploma as evidence of fitness to pursue professional studies, stipulating only that the holder shall possess an adequate knowledge of inorganic chemistry. Whether the example set by these schools will be generally followed is quite doubtful. Without

undervaluing the importance of collegiate training as a preparation for a professional career it may perhaps be contended that a properly conducted admission examination is a better test of fitness to pursue the study of medicine than the possession of a diploma the value of which varies so much with the character of the college bestowing it. Moreover, the possibility that a young man, unable to afford the expense of a college course, may yet by private study prepare himself for a professional career is not to be lost sight of. Hence the Harvard school provides for the admission by special vote of the faculty of young men, not holders of an A.B. degree, who may furnish satisfactory evidence that they have obtained an equivalent education and that they are consequently able to profit by the instruction which the school has to offer.

The recent lengthening of the course of study, from three years to four, in all the best medical schools of the country, has drawn renewed attention to the importance of enabling the student who takes the A.B. degree as a preparation for medicine, to so far shorten the sum total of the time devoted to his education, that he may be able to enter upon the work of his profession at an age not in excess of that at which his European confrères begin their career as practitioners. A few years ago an examination of the best accessible evidence on the subject led to the conclusion that foreign systems of university education enabled students of medicine to enter upon their life-work at least two years earlier than was possible for the alumni of Harvard College, a condition dependent upon the fact that the changes in the academic department, which had raised the age of graduation, had been made with little regard to the interests of the professional schools, and chiefly for the purpose of making the undergraduate department as complete as possible in itself. In other univer-

sities a similar condition existed, though probably not in the same degree, as in Harvard.

That the American medical student, seeking the best possible preparation for his profession, is seriously handicapped by these conditions has been generally recognized, and the question of the best method of meeting the difficulty has been widely discussed. The most thorough treatment of the case consists in reducing the academic course to three years. Less radical methods are the provision in the academic department of courses of instruction by which students may anticipate a part of their professional work, and the permission to count the first year of a professional course as the fourth year for the bachelor's degree. The first and most radical method meets with strenuous opposition, owing to the deeply-rooted traditions which surround the four years' academic course in this country, while the other plans violate what in some colleges seems to be regarded as an educational axiom: that one course of study should not count toward two degrees. It is interesting to notice that, without any specific legislation to this end the quiet working of the elective system has, in Harvard College, practically solved the problem by bringing about a condition in which, as President Eliot says: \* "Any young man of fair abilities can now procure the degree in three years without hurry or overwork, if he wishes to do so or his parents wish to have him." The President further ventures to predict that "within a time comparatively short, the majority of those who enter the Freshman class will come to college with the purpose of completing the requirement for the degree in three years." As soon as a three years' residence becomes the rule rather than the exception, a young man spending four years in college will, of course,

be regarded either as deficient in mental capacity or as having wasted his time.

That a reduction of the academic course to three years is an advantage to students looking forward to a professional career, or to further study in a graduate school is too obvious to need discussion, but it is interesting to find the change advocated in the interest of the undergraduates themselves. Professor Clement L. Smith, for nine years Dean of Harvard College, points out\* that there is a large and influential class of college men who get into the habit of frittering away their time simply because they have so much of it and that "for them and for those whom they influence—and these make up the largest part of the class we are now considering, the men who go from college into active life—the reduction of the course would be a distinct gain." Nor need we fear (as has sometimes been urged) that, in thus reducing the length of the college course, we shall lose the fourth and most valuable year, for as Professor Smith says: "The senior year is the best year, not because it is the fourth, but because it is the last year. The causes which make it what it is come from before, not from behind; from the consciousness of opportunity passing away and of the serious problems of life close at hand. The period of waste lies between the fresh zeal and good resolutions with which the youth begins his course, and the growing sense of responsibility with which he draws near its close. It is this intermediate period that would be shortened, in the briefer course. It is not the senior year that would be cut off; it is rather, let us say, the sophomore year, and with it might well go its absurd name."

It thus appears that the claims of the college and of the professional school upon the time of the student are in a fair way to be harmoniously adjusted.

\* Annual reports of the president and treasurer of Harvard College, 1898-99, page 10.

\* The American College in the Twentieth Century, Clement L. Smith, *Atlantic Monthly*, Feb., 1900.

## THE ELECTIVE SYSTEM.

Let us now consider in what way the medical school of the immediate future is likely to differ from that of the present time with regard to the subject matter of instruction. The most striking phenomenon presenting itself to the educator of to-day is the recent enormous widening of the educational horizon. "The immense deepening and widening of human knowledge in the nineteenth century and the increasing sense of the sanctity of the individual's gifts and will power"\* are the fundamental facts which underlie the development of the elective system, but it is important to bear in mind that, as Professor Smith observes,† this development has been "due not so much to increase of knowledge—for not all new knowledge is straightway fit for educational purposes—but rather to the conversion of new fields of knowledge to the uses of education."

A discussion of the elective system of education with its attendant advantages and dangers would require far more time than I have at my disposal and I must content myself with pointing out the possibility that, in this period of transition, the educational pendulum may have swung to an extreme position and that too much attention has been given to the accidental differences of pupils while the essential similarity of their natures has been lost sight of. In discussions on individuality as a basis for the elective system one sometimes hears the statement (attributed to Leibnitz) that no two leaves of the same tree are alike. This dissimilarity however, does not prevent them from all elaborating the same sap and it is, moreover, always associated with sufficient essential similarity to enable any one, with even the most elementary knowledge of trees, to distinguish the leaves of an oak from those of a maple.

\* C. W. Eliot, *Atlantic Monthly*, Oct., 1899, p. 443.

† C. L. Smith, *Atlantic Monthly*, Feb., 1900, p. 219.

While admitting that some of the extreme positions now maintained by the advocates of the elective system may, in the future, have to be abandoned, no one can doubt the wisdom of adapting the education to the powers of the mind to be educated and of allowing, in the case of advanced students, the choice of the individual to be a determining factor in the selection of studies. Let us, therefore, enquire to what extent the elective system may properly find a place in the curriculum of our medical schools. That it forms an essential feature of our postgraduate schools of medicine scarcely needs to be mentioned, for these schools have been organized for the express purpose of enabling graduates in medicine to select such subjects for study as may seem to them desirable and to acquire more advanced knowledge than was possible in the undergraduate course. Moreover, in some of our larger schools, since the establishment of the compulsory four years' course, a portion of the instruction of the fourth year has been given in elective courses in various specialties. The elective system in medicine is, therefore, not altogether a novelty, and the question now before us is whether it may be profitably extended to the earlier years of the course.

In his remarks at the dinner of the Harvard Medical Alumni Association in 1895, President Eliot used the following language: "There ought to be in the Harvard Medical School an extended instruction far beyond the limits of any one student's capacity. This involves, of course, some optional or elective system within the school itself, whereby the individual student should take what is, for him, the best four years' worth, the faculty supplying teaching which it might take a single student eight, twelve or twenty years to pursue."\*

One year ago last December, in an address which I had the honor to deliver in

\* Bulletin Harv. Med. Alumni Assoc., No. 8, p. 40.

New York before the American Society of Naturalists,\* I gave the reasons which seemed to me conclusive in favor of this extension of the elective system and, with your permission, I will take the liberty of presenting as briefly as possible the views there set forth.

In the first place it may be assumed that a medical school of the first rank should be an institution in which the most advanced instruction in all departments of medicine can be obtained, and on this assumption it is, of course, impossible to arrange a course of study that every student must follow in all its details, for, in the time which may properly be devoted to a course of professional study, it is quite impossible for even the most intelligent students to assimilate all the varied information which such a school may be reasonably expected to impart.

It seems, therefore, to be evident that in arranging a course of medical study a distinction must be made between those subjects which it is *essential* that *every* student should know and those subjects which it is *desirable* that *certain* students should know, that is, between those things of which no man who calls himself a physician can afford to be ignorant and those which are important for certain physicians but not for all; in other words, provision must be made both for required and for elective studies. The task of drawing the line between the essential and the desirable in medical education will require the greatest possible good judgment and readiness for mutual concession on the part of those engaged in the work, but there is no reason to fear that the difficulties will be found insuperable when the importance of the change has once been recognized.

Any one who is familiar with the existing methods of medical instruction is aware that

in nearly every department many things are taught which are subsequently found to be of use to only a fraction of those receiving the instruction. Thus the surgical anatomy of hernia is taught to men who will subsequently devote themselves to dermatology, future obstetricians are required to master the details of physiological optics and the microscopical anatomy of muscles forms a part of the instruction of men destined to a career as alienists. Now no one can doubt the propriety of including instruction on all these subjects in the curriculum of a medical school, but it may be fairly questioned whether every student should be forced to take instruction in them all.

To better indicate the nature of the reform which I am advocating, allow me to describe a possible arrangement of a course of study in the department of physiology, with which I am of course more familiar than with any other. An experienced lecturer will probably find it possible to condense into a course of about forty or fifty lectures all the most important facts of physiology with which every educated physician must necessarily be familiar. Attendance upon these lectures, combined with suitable courses of text-book instruction and laboratory work, would suffice to guard against gross ignorance of physiological principles. In addition to this work, all of which should be required, short courses of not more than eight or ten lectures each, should be provided, giving advanced instruction in such subjects as the physiology of the special senses, cerebral localization, nerve-muscle physiology, the internal secretion of glands, the physiology of the heart, circulation and respiration, the digestive secretions, the reproductive organs, etc. These courses should be elective in the sense that no student should be required to take them all. Each student might, however, very properly be required to choose a certain number of

\*See SCIENCE, N. S., Vol. VIII., No. 209, p. 921 and *Boston Med. and Surg. Journal*, December 29, 1898.

courses, which, when once chosen, become, for the student choosing them, required courses leading to examination. There is in my opinion, no doubt that an arrangement of instruction similar to that here suggested for physiology could be advantageously adopted in the departments of anatomy, histology, bacteriology, medical chemistry, pathology, surgery, and in the courses of instruction in the various special diseases, such as dermatology, ophthalmology, etc.

In the existing state of medical education the introduction of the elective system in some form or other seems to be an essential condition to any further important advance, for the curriculum of most of our schools is already so crowded that no considerable amount of instruction can possibly be added. Various arguments may, of course, be advanced in opposition to the change. It may perhaps be urged that no choice of studies can be made without determining to some extent the direction in which the work of a future practitioner is to be specialized and that such specialization cannot be properly and safely permitted until the student has completed his medical studies. To this it may be answered that, whatever may be the dangers of too early specialization, the dangers of crowding the medical course with instruction of which many students do not feel the need, and of thus encouraging perfunctory and superficial work, are a certainty no less serious. It is, moreover, a matter of common observation among teachers in medical schools that a certain number of students very early make up their minds either that they will become surgeons, obstetricians, or specialists of some sort, or, on the other hand, that they have a strong aversion to certain branches of medicine and a determination never to practice them. For such students a prescribed curriculum necessarily involves great loss of time and energy.

If it be said that under this system the

medical degree will cease to have the definite meaning now attached to it and that it will be impossible to tell from his diploma in what way a physician has been educated, it may be replied that, though the degrees of A.B., A.M., Ph.D. and S.D. are affected with exactly this same uncertainty of signification, their value seems in no way diminished thereby. As long as the M.D. degree stands for a definite amount of serious work on medical subjects, we may be reasonably sure that those who hold it will be safe custodians of the health of the community in which they practise.

If it be urged that the elective system in medical education will lead to the production of a class of physicians who, owing to the early specialization of their work, will be inclined to overrate the importance of their specialty and to see in every disease an opportunity for the display of their special skill, it may be pointed out that this result is apt to be due not so much to early as to imperfect instruction in the work of a specialist, and that since the elective system tends to encourage thoroughness in special instruction, the evil may be expected to diminish rather than to increase.

#### METHODS OF INSTRUCTION.

Having thus recognized the necessity of remodeling our conception of the subject matter to be taught and noted the importance of distinguishing between the essential and the desirable in medical education we must next consider by what methods the needed information may be best imparted and the necessary training secured. There is perhaps no way in which modern educational methods differ more from those of an earlier period than in the greater prominence given to object lessons. Beginning with the kindergarten the child is trained to cultivate his power to observe accurately and to manipulate skilfully and, through his school and college life, prominence is

given to the objective side of education to an extent which would have seemed to the book-trained pedagogues of a former generation but ill adapted to provide the well-stored mind which it was thought to be the principal object of education to secure. In the professional schools also the reaction against purely didactic methods has been strongly felt. Even in those professional pursuits to which the object method might seem at first sight least applicable, in the study of the law, the so-called 'case method' of instruction has been found to exert a vivifying influence.

In medical education in this country it is interesting to note that, in the very beginning, the instruction was more objective in its character than at a somewhat later period. In those early days it was in the office of his preceptor and at the bedside, as his actual assistant, that the embryo physician was initiated into the mysteries of his calling. Then followed a period when it was clearly perceived that the trained mind is necessary to interpret the data of observation and that mental training is essential to correct observing. Hence schools were established to provide this training by means of systematic didactic lectures covering all the departments of medicine and usually extending over not more than four months. These schools were intended at first merely to supplement the work of the preceptors but in process of time the relative importance of these two educational agencies was reversed and the work of the preceptors, became supplementary to that of the schools. The function of the preceptors finally became so subordinate that their names no longer appeared in the catalogues though this did not always indicate that they had ceased to afford students opportunities for practical clinical work.\*

\* See address by Henry Hun, M.D., *Albany Medical Annals*, October, 1896.

The schools, once established, grew chiefly by an increase in the length and number of the lecture courses as new and important subjects forced themselves upon the attention of the medical profession. Against this undue extension of purely didactic methods of instruction a reaction has now set in and during the last ten or fifteen years loud voices have been raised in advocacy of more objective methods than those at present in use. It is not, however, the reinstatement of the preceptor that is urged but rather the greater use of laboratory methods in the strictly scientific departments of medical instruction and their application as far as possible at the bedside of the patient. A fruitful discussion of the relative advantages of the laboratory, the lecture and the text-book as methods of medical education cannot be undertaken without a recognition of the fact that this education has a double object. In the first place the faculties of the student are to be so trained that he may observe carefully, reason correctly, study effectively and judge wisely; in other words, he is to be 'trained for power' to use President Eliot's phrase. In the second place there must be imparted to him a sufficiently large fraction of the acquired medical knowledge of the time to make him a safe custodian of the health of the community. Which of these two objects is the more important is a question which we need not now discuss, but even if we grant all that is claimed by the advocates of training for power it is evident that the constantly increasing range of subjects with regard to which an educated physician must be informed will greatly reduce the time which, in the curriculum of a medical school, may properly be devoted to courses of instruction not intended to impart direct and valuable information. In fact, 'training for power' should be largely a function of the academic department of a university, and, when undertaken

in a professional school, should be so directed as to impart at the same time the greatest possible amount of useful information.

Let us now consider how far the didactic and the laboratory methods of instruction are each adapted to secure these two objects of medical education. For the purpose of training for power no one can doubt the value of the laboratory method. Contact with the phenomena themselves and not with descriptions of them has a stimulating effect upon the mind of a student, the importance of which it is difficult to exaggerate, but it does not follow from this that the lecture, the recitation and the text-book are worthless as methods of training. It is here that some of the advocates of laboratory methods have committed what appears to me a serious error such as is too apt to characterize all reform movements, the error, namely, of assuming that because one proposition is true, another proposition, not logically inconsistent with it, must be untrue. "These gentlemen," as Professor Howell\* has expressed it, "having become possessed of the golden truth that the best knowledge is that which comes from personal experience, seem disposed to deny all value to knowledge communicated from the experience of others." We are told, for instance, by Dr. Burr,† that the didactic lecture "dates from the time when printing was unknown and manuscripts were rare and almost priceless and the only means of communicating knowledge was by word of mouth. To-day it is in large part an anachronism, because the time devoted to it could be put to better uses."

In his able address‡ at the last Yale University Medical Commencement my colleague, Dr. C. S. Minot, expressed himself

as follows: "The very best that can be said of a lecture or a book is that it describes well the knowledge which someone possesses. There is no knowledge in books. \* \* \* A book or a lecture can serve only to assist a man to acquire knowledge with lessened loss of time. Knowledge lives in the laboratory; when it is dead we bury it decently in a book. \* \* \* A lecture is a spoken book." I venture to believe that Professor Minot's students will hardly agree with this estimate of the lifeless character of either his written or his spoken instruction.

In place of these rather disparaging views of the importance of a didactic lecture, I am inclined to accept Dr. Weir Mitchell's\* opinion that "The best lecturing does not so much think for you as invite you to think along suggested lines of enquiry." If, as has been claimed, "the passive attitude of listening does not demand of the students intelligent thought,"† the fault must lie with the lecturer and not with the method of instruction. In every department of medicine advanced instruction necessarily deals with subjects which lie within what Foster has called the 'penumbra' of solid scientific acquisition, and about which conflicting views are, therefore, certain to be held. It is in inviting thought, with regard to the evidence on which these views rest, that the experienced lecturer has his best opportunity to train the minds of his hearers. Other opportunities are also afforded by the historical presentation of subjects about which differences of opinion no longer exist, for there are few things more instructive than to follow up, step by step, the lines by which our knowledge has advanced, noting

\* *The Michigan Alumnus*, Jan., 1900, Vol. VI., p. 143.

† *Philadelphia Medical Journal*, Oct. 21, 1899.

‡ *SCIENCE*, July 7, 1899.

\* *University Bulletin*, Vol. III., p. 85. Phila., Dec., 1898.

† W. B. Cannon, A.M. *The Case Method of Teaching Systematic Medicine*. *Boston Med. and Surg. Journ.*, Jan. 11, 1900.

the marks which distinguish the paths which have been trodden successfully from those which have turned out to be 'No Thoroughfare.' Even better opportunities for mental training than those which the lecture room presents, are afforded by the recitation, for here the minds of the teacher and the pupil are brought most closely into contact, the pupil's difficulties are appreciated by the instructor, and the point of view of the teacher can be learned by the pupil. It has always seemed to me that no higher enjoyment falls to the lot of the teacher than that which he experiences when, by a series of carefully considered questions, he leads his pupil onward from the known to the unknown, and notes the gleam of intelligence which illumines his countenance as a subject, previously obscure, becomes clear, as a result of his own mental operations, guided by his teacher's skilful questions. It thus appears that no monopoly of opportunities for mental training can be claimed for the laboratory method of instruction.

We must next inquire: what are the relative advantages of the laboratory and didactic methods as means of imparting information? Here we at once perceive that a great deal will depend upon the kind of information to be imparted. Certain subjects are much better adapted than others to be taught in the laboratory. The student of anatomy, for instance, can secure the greater part of the information which he needs by laboratory methods, *i. e.*, in the dissecting room, though a short course of lectures on descriptive anatomy in which an experienced teacher emphasizes the salient features of the subject will probably always be indispensable. Physiology and pathology (including physiological chemistry, pharmacology and bacteriology) are subjects in which laboratory instruction may be unquestionably much more freely used than is customary at the

present time. The recent experience of the Harvard Medical School, in which the laboratory courses in these subjects have been greatly extended, has furnished conclusive evidence of the value of this method of instruction as a means both of imparting information and of stimulating the mind of the student. It must be remembered, however, that, as Dr. Welch\* has said, "laboratory methods are extremely time-taking and are not adapted to teach the whole contents of any of the medical sciences. It is, of course, hopeless to attempt to demonstrate practically all of even the more important facts that the student should learn."

Moreover, observed facts are often apparently inconsistent with each other. Equally competent observers differ in their interpretation of them. Yet, because the last word of science has not been spoken on these subjects, it would be a mistake to exclude them from the medical curriculum. The student should rather be carefully instructed as to researches which have not yet yielded definite results. The most profitable way of reconciling conflicting observations should be pointed out, and he should be shown in what direction the search for truth can be prosecuted with the best prospect of success. He will then be able to appreciate the value of new observations and to assign to their true position the reported discoveries in medical science.

Instruction of this sort can, of course, be given only by an experienced lecturer who has mastered the subject of which he treats. It is in this kind of teaching and in the exposition of those facts and principles which cannot properly be made the subject of laboratory instruction to students that the didactic lecture of the future will probably find its principal field of usefulness. In the latter direction, however, the field is

\* Higher Medical Education and the Need of its Endowment. *The Medical News*, July 28, 1894.

more restricted than might, at first sight, appear for the amount of practical work that can be successfully performed by first- and second-year students in a physiological or in a pathological laboratory is surprisingly large. In the physiological department of the Harvard Medical School, for instance, during the current academic year each pair of students in a class of 180 has been furnished with a kymographion, a capillary electrometer, a moist chamber, an induction coil, unpolarizable electrodes, etc., and the most important experiments of nerve-muscle physiology have been successfully repeated. The fundamental experiments in the physiology of the circulation, respiration, etc., are to be performed in a similar manner. In the pathological laboratory the students, working in sections of ten, have had an opportunity of producing for themselves and studying experimentally the most important pathological degenerations. They have also studied in the same way the principal infectious diseases. In the anatomical department also, while the number of didactic lectures has been diminished, the whole class has had largely increased facilities for the practical study of bones and of various special organs.

Still, after making due allowance for the legitimate expansion of laboratory teaching, it is probably safe to say that a systematic course of lectures in each of the medical sciences will never be found to be superfluous and that the day is probably far distant when the lectures will be merely 'explanatory of the experiments.'\*

We have thus far considered the relative advantages of didactic and laboratory methods in teaching the medical sciences, but the agitation in favor of objective teaching has extended also to the clinical departments of medicine and the organization of 'clinical laboratories,' in which the

cases of hospital patients may be studied by the most refined methods of physiological and pathological research, is a natural outcome of this agitation. In fact, however, so far as instruction is actually given at the bedside, clinical medicine has always been taught by means of object lessons. In many of our schools this instruction has been supplemented by so-called 'conferences,' exercises in which a student reports before the class a case which he has himself examined, giving diagnosis, prognosis and treatment. The subject is then discussed by the class and finally by the instructors.

Wherever actual cases of disease are thus utilized for teaching purposes the instruction is always likely to be more or less haphazard and unsystematic, for the diseases studied will be those of which actual cases happen to be available. To remedy this difficulty it has been recently proposed\* to substitute the study of hospital records of cases for the examination of the cases themselves, a method quite analogous to that known as the 'case-method' which has long been used with great success in training students in the Harvard Law School. It will thus be possible to group cases so that they will throw light upon each other and, though the student will miss the stimulus of contact with the actual patient, the method presents so many distinct advantages that it will doubtless commend itself to many teachers of clinical medicine and of theory and practice.

It is thus evident that the reaction against purely didactic methods of instruction is well under way. It is a movement to be heartily welcomed, for there can be no doubt that medical students have been and still are too much lectured, but, like all other reforms, it should be carefully guided lest useful as well as useless things be swept away. It should be borne in mind that it

\* Porter, *Boston Med. and Surg. Journal*, Dec. 29, 1898.

\* W. B. Cannon, A.M., I. c.

is quite as easy to abuse the laboratory as the didactic method of instruction and that in all schemes of education a good teacher with a bad method is more effective than a bad teacher with a good method. As Professor Howell\* has well remarked, "courses of lectures, that, if analyzed would be found to be top-heavy and lopsided, and otherwise possessed of an instability that should have insured failure, have been saved and made instruments of great value by the mere earnestness of the teacher."

#### DISTRIBUTION OF WORK.

The next question which I shall ask you to consider is that of the proper distribution of the work of a medical student. Thirty years ago no such question seems to have presented itself to the minds of instructors in medicine. The medical faculties of that time contented themselves with providing, each year, courses of lectures covering all the departments of medicine, as they were then understood, and every student was expected to attend as many of the lectures as he saw fit. Between 1870 and 1880 the fact that there is a natural sequence in medical studies became generally recognized and graded courses of instruction were established in the principal medical schools of the country. The grading, was not, however, carried sufficiently far. Thus instruction in both anatomy and physiology was generally given simultaneously through the whole of the first year, though the knowledge of structure should logically *precede* a study of function.

The time seems now to have come for taking another step in grading medical instruction and, during the academic year now drawing to a close, instruction in the Harvard Medical School has been given in accordance with a plan of which the guiding principles are concentration of work and sequence of subjects. Thus in the first

half of the first year the students devote themselves exclusively to the study of anatomy including histology and embryology. In the second half year they are occupied with physiology, including physiological chemistry, while in the first half of the second year pathology, including bacteriology, engages their attention. It is perhaps too early to pass a final judgment upon the value of the method but thus far both teachers and students seem to regard it as a success. The result seems to have justified the opinion of its advocates that the work of the student would be made 'easier by concentrating his thoughts upon one subject instead of dissipating his attention upon many subjects.\* Nor have its opponents found any justification for their fears that the average brain would become fatigued and unreceptive by too close application to one subject for the sciences of anatomy, physiology and pathology 'are not narrow hedged in areas but rather broad and diversified domains composed of many contiguous fields,'† in passing from one to another of which the student may rest his mind without interrupting the continuity of effort essential to effective work.

An obvious objection to this method of concentrating instruction is the large amount of work which it imposes upon the instructors. There is no doubt that the labor of teaching every day in the week may task the powers of even the most enthusiastic instructor, but it has been found that the laboratory work which has occupied from two to three hours every forenoon has been conducted with much less fatigue than was anticipated. In fact students, when supplied with printed directions for work and with the necessary apparatus, need remarkably little supervision. In the physiological laboratory it was found that one instructor could readily supervise

\* Minot, l. c., Reprint, p. 22.

† Porter, l. c., Reprint, p. 12.

\* l. c., p. 144.

the work of fifteen pairs of students, and the experience in the anatomical and pathological departments was of a similar sort.

#### EXAMINATIONS.

Closely connected with the questions of method of instruction and of distribution of work is the subject of examinations. With regard to these tests of our educational methods, opinions vary even more widely than with regard to the methods themselves. There is only one point, as Professor Exner has remarked, on which teachers are practically united, and that is, "that an examination is a necessary evil." Every examiner knows only too well that an examination is but a very imperfect test of knowledge, but few are ready with any suggestion of a substitute. Much of the confusion which prevails in the discussion of this subject would be removed if the objects to be secured by an examination were more clearly apprehended. Professor Exner\* points out that examinations may be broadly divided into two classes, viz, the *Controlprüfung*, to test the faithfulness with which the student has performed his daily tasks, and the *Reifeprüfung* to determine the amount of his permanently acquired knowledge of medical subjects.

The examination, which, at the end of the year, covers the whole ground of the previous twelve months' instruction and which is so common in our schools, belongs to neither of these two classes and is really a concession to a very natural wish of the students to get the examination 'out of the way' while the subject is still fresh in their minds. Having little justification from an educational point of view we may hope to see it abandoned when the extension of laboratory methods provides in the notebook and graphic records of each student the evidence of his daily work, and thus either renders a further examination un-

necessary or prepares the way for a final test of his fitness to receive his diploma of M.D. Whether the written or the oral examination affords the better method of applying this test is a question about which opinions vary. The fact that some persons can write more readily than they can talk, while others can talk more readily than they can write, seems to be a reason for providing a mixed method of examination in which each individual may have an opportunity of appearing to the best advantage.

#### CONCLUSIONS.

If the views here presented are well founded we may expect that a medical school of the first rank will, in the immediate future, be organized and administered somewhat as follows:

I. It will be connected with a university but will be so far independent of university control that the faculty will practically decide all questions relating to methods of instruction and the personnel of the teaching body.

II. It will offer advanced instruction in every department of medicine, and will therefore necessarily adopt an elective system of some sort, since the amount of instruction provided will be far more than any one student can follow.

III. The laboratory method of instruction will be greatly extended, and students will be trained to get their knowledge, as far as possible, by the direct study of nature, but the didactic lecture, though reduced in importance, will not be displaced from its position as an educational agency.

IV. The work of the students will probably be so arranged that their attention will be concentrated upon one principal subject at a time, and these subjects will follow each other in a natural order.

V. Examinations will be so conducted as to afford a test of both the faithfulness

\* I. c., Reprint.

with which a student performs his daily work and of his permanent acquisition of medical knowledge fitting him to practise his profession.

If I have clothed these conclusions in the language of prophecy it is because the title of my discourse has laid this necessity upon me. In forecasting the immediate future, I have borne in mind the history of the immediate past and, if I have failed to read aright the indications of the lines on which our medical schools are to advance, it must be remembered that the development of a biological science and of its dependent arts not infrequently takes place in totally unexpected directions, thus introducing into the path of educational progress perturbations which may well defy prediction.

H. P. BOWDITCH.

HARVARD MEDICAL SCHOOL.

---

NATIONAL STANDARDIZING BUREAU.\*

TREASURY DEPARTMENT,

OFFICE OF THE SECRETARY,

Washington, April 18, 1900.

SIR: I have the honor to submit herewith the following draft of an amendment to the sundry civil bill, now pending in the Committee on Appropriations, and to recommend that the necessary appropriation to carry the same into operation and effect may be included therein:

That the Office of Standard Weights and Measures shall hereafter be known as the National Standardizing Bureau, and shall remain under the control of the Secretary of the Treasury.

The functions of the bureau shall consist in the custody of the standards; the comparison of the standards used in scientific investigations, engineering, manufacturing, commerce, and educational institutions with the standards

\* Letter from the Secretary of the Treasury, transmitting, with accompanying communications, a draft of a bill for the establishment of a National Standardizing Bureau.

adopted or recognized by the Government; the construction when necessary of standards, their multiples, and subdivisions; the testing and calibration of standard measuring apparatus; the solution of problems which arise in connection with standards; the determination of physical constants, and the properties of materials when such data are of great importance to scientific or manufacturing interests and are not to be obtained of sufficient accuracy elsewhere.

The bureau shall exercise its functions for the Government of the United States; for any State or municipal government within the United States, or for any scientific society, educational institution, firm, corporation, or individual within the United States engaged in manufacturing or other pursuits requiring the use of standards or standard measuring instruments. All requests for the services of the Bureau shall be made in accordance with the rules and regulations herein established.

The officers and employees of the bureau shall consist of a director, at an annual salary of six thousand dollars; one physicist, at an annual salary of thirty-five hundred dollars; one chemist, at an annual salary of thirty-five hundred dollars; two assistant physicists or chemists, each at an annual salary of twenty-two hundred dollars; two laboratory assistants, each at an annual salary of fourteen hundred dollars; two laboratory assistants, each at an annual salary of twelve hundred dollars; one secretary, at an annual salary of two thousand dollars; one clerk, at an annual salary of twelve hundred dollars; one clerk, at an annual salary of one thousand dollars; one messenger, at an annual salary of seven hundred and twenty dollars; one engineer, at an annual salary of fifteen hundred dollars; one fireman, at an annual salary of seven hundred and twenty dollars; one mechanic, at an annual salary of fourteen hundred dollars; one mechanic, at an annual salary of one thousand dollars; one mechanic, at an annual salary of eight hundred and forty dollars; one watchman, at an annual salary of seven hundred and twenty dollars, and two laborers, each at an annual salary of six hundred dollars.

The director shall be appointed by the Presi-